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RESEARCH ARTICLE

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Investigating the "Twelfth Man" Effect in Five European Domestic Football Leagues: A COVID-19 Induced Natural Experiment

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ABSTRACT

This study examines whether there is a quantifiable change in the magnitude of home advantage (HA) when football matches are contested behind closed doors. The study incorporates the highest divisions of football leagues in England, Germany, Italy, Portugal, and Spain. Due to COVID-19 restrictions, 506 fixtures were played without crowds across these leagues during the 2019/20 season. We conducted inter-season analysis comparing HA between the 2019/20 season and the 2018/19 season (when crowds were present). We also conducted intra-season analysis comparing HA between fixtures played with and without crowds during the 2019/20 season. The Italian Serie A and the German Bundesliga were the only leagues where any evidence of a significant decline in inter-season HA (between 2018/19 and 2019/2020) or intra-season HA (between fixtures with and without crowds in 2019/20) was found. Overall, there is insufficient evidence to generalize that the absence of crowds affects HA in football.

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1. Introduction

COVID-19 has had far-reaching consequences for the health and wellbeing of individuals and for economies across the world. Like other sectors of society, sport has not been immune to the effects of the pandemic and has been affected severely by the subsequent measures put in place by national governments to mitigate the spread of the virus. Several high-profile sporting events scheduled to take place during 2020 were either cancelled (e.g. Wimbledon 2020) or postponed (e.g. the Tokyo 2020 Olympic and Paralympic Games). During March 2020, the schedules of most domestic football leagues around Europe were disrupted due to COVID-19, which subsequently led to some leagues abandoning the outstanding fixtures of their respective seasons (e.g. Ligue 1 in France; League One and League Two in England). Most leagues that did eventually resume their incomplete seasons at some point in

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2020 did so behind closed doors, which meant that home and away fans were not allowed in the stadia to spectate.

In team sports like football that feature 11 players per side, the term "twelfth man" (Buraimo et al., 2010) is sometimes used casually in reference to the home crowd, in recognition of their presumed influence on the behavioral responses of players and referees. Indeed, an advantage derived from playing at home has been shown to exist in several professional teams sports worldwide (Pollard et al., 2017). Within football, a study encompassing the national domestic leagues of 157 countries by Pollard and Gómez (2014a) demonstrated the prevalence of a home advantage (HA) in all continents. A separate study by the same authors concluded that the HA effect was also evident in women's football leagues throughout Europe (Pollard & Gómez, 2014b). While football fans and supporters tend to perceive that crowd support is a major contributory factor for HA (Smith, 2005; Wolfson et al., 2005), the effect of the crowd has been difficult to establish, let alone quantify (Leite & Pollard, 2018).

The purpose of this paper is to examine whether playing matches behind closed doors has had a significant effect on the extent to which football teams competing in European football leagues benefitted from a quantifiable HA in the absence of crowds. This paper draws on data relating to the highest divisions of football leagues in five European countries. The rest of the paper is organized in the following order. We first review briefly the main conceptual models that have been developed to guide understanding of the occurrence of HA in sport. We then examine the empirical evidence from previous studies designed to investigate the effects of the crowd on HA, which in turn provides the basis for shaping our research questions. The details of the methods used are then presented followed by the results obtained. In the final section, the key findings, implications and limitations of our study are discussed and direction for future research is proposed.

2. Conceptual Framework

The most comprehensive and well-researched conceptual model that attempts to explain the phenomenon of HA was developed originally by Courneya and Carron (1992) and refined by Carron et al. (2005). The original framework proposed by Courneya and Carron (1992) incorporated five major components: (1) game location; (2) game location factors; (3) critical psychological states; (4) critical behavioral states; and, (5) performance outcomes. In this framework, "game location" is either home or away depending on where the competition takes place. There are four "game location factors" that differentially impact on athletes and teams competing at home or away from home, namely: (1) the support of the home crowd; (2) familiarity with the home venue; (3) travel fatigue of the away team; and, (4) competition rules in certain sports that may favor the home team.

Courneya and Carron (1992) contended that these four factors contribute to the "psychological states" of competitors, coaches and officials that in turn influences the "behavioral states" (responses) of these individuals, which ultimately tend to favor home athletes and teams. According to their framework, "performance outcomes" influenced by game location can be measured at three levels. The three

levels are: "primary", relating to fundamental skill execution (e.g. possession, successful passes, etc.); "secondary", reflecting the scoring aspect of performance (e.g. number of goals scored or conceded); and, "tertiary", representing the final outcome of the contest (win, draw, or loss).

Carron et al. (2005) proposed two amendments to Courneya and Carron's (1992) original HA model. First, "officials" were excluded in the revised iteration, not because they do not potentially contribute to HA but as, unlike competitors and coaches, they do not have a designated home or visitor status. Second, the revised model incorporated the "critical physiological states" of competitors and coaches that are associated with game location. The rationale for the inclusion of physiological states in Carron et al.'s (2005) revised HA model was informed by the work of Neave and Wolfson (2003), who proposed that the competitive context of organized sport invokes the natural protective response to territorial intrusion in human beings, combined with the evidence provided by other researchers on the adverse effects of jet lag on athletic performance (Jehue et al., 1993; Recht et al., 1995). Studies of territoriality in some team sports have shown that testosterone concentrations of players were considerably higher before home games compared with before away games (Neave & Wolfson, 2003; Carré et al., 2006). Rises in testosterone are thought to benefit athletic performance because they coincide with greater physical aggression and motivation to compete (Wood & Stanton, 2012).

Another hormone that changes in response to game location is cortisol (Allen & Jones, 2014) and there is research showing that cortisol levels are elevated prior to competing at home venues (Carré et al., 2006; Fothergill et al., 2017), which is indicative of a higher level of stress before home games. Feeling stressed or under pressure to perform in front of home fans could in turn have a detrimental effect on athletic performance such that HA is diluted or even reversed. This is the premise for another conceptual model, according to which the pressure of performing in front of a supportive audience can in certain situations trigger a "choking" response among home athletes and teams, resulting in a home disadvantage. This notion was first introduced by Baumeister and Steinhilber (1984). Butler and Baumeister (1998) found that participants in laboratory experiments performed less well when performing for supportive versus unsupportive audiences. Wallace et al. (2005) contend that the mechanism through which performance pressure induces choking is by changing performers' attentional focus to avoid failure rather than seek success during the most critical moments of sporting contests. It has also been suggested that performers are not aware of the debilitating effects of supportive audiences (Butler & Baumeister, 1998) and that a friendly environment induces individuals to choke when performing skill-based tasks (Harb-Wu & Krumer, 2017).

3. Evidence Review

Crowds have been identified as a "game location factor" that contributes to the occurrence of HA in sport (Courneya & Carron, 1992; Carron et al., 2005). Previous research efforts on the effects of the crowd on HA can be grouped into two broad themes. First, studies that utilize archival data to examine the relationship between HA (operationalized using various indicators of match outcome, team performance

and/or referee bias) and crowd-related factors (i.e. crowd size, crowd density and crowd proximity). Second, experimental research designed specifically to test whether crowd noise influences referees and officials to favor the home team. Our study is aligned closely with the former theme.

Despite the view held by supporters that the home crowd can influence refereeing decisions in favor of the home team, intimidate opponents of the away team and positively influence the performance of home team players (Smith, 2005; Wolfson et al., 2005), archival studies into the effect of crowd-related factors on HA have yielded inconsistent findings. Some researchers have demonstrated an association between crowd size and HA. For example, Goumas (2013) analyzed data relating to the percentage of all goals scored at home from 1935 matches of major international club football competitions in four continental confederations of the International Federation of Association Football (FIFA) – Europe, Asia, North America and South America – and found that HA increased by 1.5% per each 10% increase in crowd size. In a separate study comprising all matches from the first seven seasons (2005/06–2011/12) of the Australian A-League, the highest domestic football division in Australia, Goumas (2014a) reported that HA in terms of percentage of competition points gained by home teams appeared to increase with increasing crowd size but only up to about 20,000 persons. More recently, Ponzo and Scoppa (2018) analyzed same-stadium derbies (matches among teams that share the same stadium) contested in the Italian Serie A across 22 seasons. Their results indicate that HA is manifested in two ways. First, the existence of a sizeable crowd support's effect on the HA generated through the encouragement of players' performance. Second, the support of the crowd tends to bias the referee's decisions (in terms of penalties, red cards, and yellow cards) in favor of the home team. It has been suggested that a likely channel that leads to the observed systematic differences in referee decisions is that social pressure from the crowd directly affects the referee, who then departs from the decision that maximizes his expected material payoff (Dohmen, 2008).

By contrast, Leite and Pollard (2018), in their analysis of HA in the top and second divisions of football leagues in 47 countries, found the correlation between mean attendance and league HA to be small and not statistically significant at both levels of competition. Their study also showed that 10 of the 47 countries had a significantly higher HA in the second division, while for only one country was HA significantly higher in the top division. A previous study comparing HA between the professional, semi-professional and amateur football leagues in Portugal reported that HA was the lowest in the professional league, which had the highest attendance (Almeida & Volossovitch, 2017). Moreover, in a study of Italian football leagues based on 20 games played without a crowd during the 2006/07 season (because the stadiums of the home teams at that time did not comply with safety rules) and on teams that share the same stadium, Van de Ven (2011) concluded that crowd support was not essential for HA to occur. Collectively, these studies indicate that leagues that attract larger crowds do not necessarily exhibit higher HA and that the absolute size of the home crowd alone does not cause HA to occur. Research has also shown that crowd density, as measured by the proportion of stadium capacity filled, does not always correlate with HA in football (Goumas, 2014b; Pollard & Armatas, 2017; Unkelbach & Memmert, 2010). With regard to crowd proximity, the absence of a

running track between spectators and the playing area has been shown to be related to an increased HA in football leagues in Germany (Dohmen, 2008) and Greece (Armatas & Pollard, 2014). However, Pollard and Armatas (2017) found that the presence or absence of a running track did not have a significant effect on HA in the group stages of qualification for the 2006, 2010, and 2014 football World Cup finals.

As a result of the unique circumstances presented by the COVID-19 pandemic, there have been some recent efforts by researchers to investigate how the absence of crowds from stadiums has affected HA in some domestic football leagues (Sors et al., 2020; Tilp & Thaller, 2020). We add to this emerging body of research by examining whether there is a quantifiable change in the magnitude of HA when football matches are contested behind closed doors using a sample of national football leagues in Europe. Specifically, we devised and tested the two research questions (RQs) outlined below:

> RQ1: Do football teams experience HA differently during a season in which a critical mass of fixtures are contested behind closed doors compared with a 'normal' season during which crowds are present?
>
> RQ2: Are fixtures played with crowds during a given season associated with higher or lower HA than fixtures contested behind closed doors during the same season?

4. Methods

4.1. Scope of the Study

This study covered five top-division football leagues in Europe, namely: La Liga (Spain); Premier League (England); the Bundesliga (Germany); Serie A (Italy); and, Primeira Liga (Portugal). The leagues included in this study represented five of the top six European countries as per UEFAs association club coefficients when the research was initiated (https://www.uefa.com/memberassociations/uefarankings/country/#/yr/2020). These coefficients are based on the results of each association's clubs in the five previous UEFA Champions League and UEFA Europa League seasons, which determine the number of places allocated to an association (country) in forthcoming UEFA club competitions. Spain has the highest association club coefficient over the period 2015/16 to 2019/20 (102.283), followed by England (90.462), Germany (74.784) and Italy (70.653). The fifth-ranked country was France (59.248); however the 2019/20 season of the French Ligue 1 was abandoned due to COVID-19 and we therefore substituted France with Portugal (49.449), the country with the next highest association club coefficient, in this study.

4.2. Empirical Strategy

In order to address RQ1, we compared the HA of teams within each league under review during the 2018/19 season, when crowds were present, with the HA of teams during the 2019/20 season, when a critical mass of fixtures were contested without crowds. The overall approach to the calculation of HA follows the method first

proposed by Pollard (1986), which has been used widely in subsequent studies by different researchers. For any given league, HA is expressed as the number of points won by teams at their home fixtures during a season as a ratio of their total points achieved in that season, both at home and away, where a ratio in excess of 0.50 (or 50%) is indicative of HA (Leite & Pollard, 2018). The greater the value above 0.50, the greater the advantage derived by playing at home. HA scores below the 0.50 threshold are indicative of a home disadvantage or visitor advantage.

Table 1 shows the number of matches played with and without crowds during the 2019/20 season for our sample of leagues. Overall nearly 29% of fixtures across the five leagues were contested behind closed doors in this season. This statistic fluctuated from 24% in the English Premier League to 34% in the Italian Serie A. All matches held behind closed doors in our sample were played at the original venue of the designated home team as scheduled prior to the COVID-19 restrictions.

Archival data relating to the home and away performances of all teams for the 2018/19 and 2019/20 seasons of each league under review were collated using publically available websites such as SoccerStats (https://www.soccerstats.com). The distribution of the match outcomes for each league is presented in Table 2.

We first examined the HA associated with all teams within each league during the 2018/19 and 2019/20 seasons (i.e. 96 teams per season across the five leagues). We then examined the HA associated with the sub-sample of teams that were present in both seasons (i.e. 81 teams per season) by excluding teams that were either relegated from the league's topmost division in 2018/19 or promoted to the league's topmost division in 2019/20.

Table 1. Distribution of matches played with and without crowds in 2019/2020.

League	Country	Number of teams	Matches with crowds	Matches behind closed doors	Total matches
La Liga	Spain	20	269 (70.8%)	111 (29.2%)	380
Premier League	England	20	288 (75.8%)	92 (24.2%)	380
Bundesliga	Germany	18	223 (72.9%)	83 (27.1%)	306
Serie A	Italy	20	250 (65.8%)	130 (34.2%)	380
Primeira Liga	Portugal	18	216 (70.6%)	90 (29.4%)	306
Overall sample		96	1246 (71.1%)	506 (28.9%)	1752

Table 2. Distribution of match outcomes for the topmost football division in five countries during 2018/19 and 2019/20.

Season	Split	Outcome	England	Germany	Italy	Spain	Portugal	Overall
2018/19	All matches	HW	181	138	166	168	143	796
		HD	71	73	108	110	62	424
		HL	128	95	106	102	101	532
2019/20	All matches	HW	172	123	158	174	126	753
		HD	92	68	85	105	79	429
		HL	116	115	137	101	101	570
2019/20	With crowds	HW	129	96	100	129	86	540
		HD	72	49	57	75	56	309
		HL	87	78	93	65	74	397
2019/20	Without crowds	HW	43	27	58	45	40	213
		HD	20	19	28	30	23	120
		HL	29	37	44	36	27	173

HW, Home Win; HD, Home Draw; HL, Home Loss.

For tackling RQ2, we computed an HA score for each fixture contested within each league during the 2019/20 season (where a home win = 1; a home draw = 0.5; and, a home loss = 0), which gave us an aggregate sample of 1752 observations. We initially compared the HA scores derived for all matches played with crowds ($n = 1246$) with the HA scores derived for all matches played behind closed doors ($n = 506$). For each league, we then separately examined differences between the HA scores for the sub-sample of fixtures played by teams in front of a stadium audience and the reverse fixtures played between the same set of teams behind closed doors during the same season. This latter comparison utilized 506 pairs of fixtures from the 2019/20 season, such that for every fixture contested without crowds we had a corresponding fixture contested with crowds.

4.3. Statistical Analysis

The data were analyzed using SPSS version 24. One sample *t*-tests were conducted to examine whether the observed HA scores for the 2018/19 and 2019/20 seasons were significantly different from the neutral value of 0.50. Differences in HA between seasons (inter-season comparison) and between fixtures contested with and without crowds during the same season (intra-season comparison) were assessed using independent sample *t*-tests (for all teams and fixtures) and paired sample *t*-tests (for sub-samples of directly comparable teams and fixtures).

5. Results

5.1. Inter-season Comparison

The mean HA scores derived for 2018/19 and 2019/20 for the five leagues included in our study are displayed in Table 3. When data from all five leagues were amalgamated, the mean HA scores for both seasons were significantly greater than the neutral score of 0.50 ($p < 0.001$) and the mean difference in HA of 0.03 (three percentage points) between 2018/19 (0.59) and 2019/20 (0.56) was also statistically significant ($p < 0.05$). However, significant differences in HA between 2018/19 and 2019/20 were only observed in two of the five leagues under review ($p < 0.05$). HA declined by nine percentage points in the German Bundesliga during 2019/20 relative to the previous season and the corresponding decline in the case of Serie A was six percentage points. The HA scores for the English Premier League, Spanish La Liga and Portuguese Primeira Liga did not change significantly between 2018/19 and 2019/20 ($p > 0.10$).

When we eliminated from the analysis any teams that had not been present in the top division in both seasons, we found a statistically significant reduction in HA for the pooled sample of all leagues ($p < 0.05$) and for Serie A only ($p < 0.01$), as illustrated by the data presented in Table 4.

5.2. Intra-season Comparison

Table 5 provides a comparison of mean HA scores for all fixtures contested with crowds and behind closed doors during the 2019/20 season. For the aggregate sample of 1752

Table 3. Comparison of HA in 2018/19 versus 2019/20 (all teams).

			HA		One sample *t*-test (test value = 0.50)		Levene's test for equality of variances		t-test for equality of means		
League (country)	Season	N	Mean	Standard deviation	*t*	Sig.	*F*	Sig.	Mean difference	*t*	Sig.
Bundesliga (Germany)	2018–19	18	0.60	0.11	3.947	0.001	0.117	0.735	0.09	2.557	0.015
	2019–20	18	0.51	0.10	0.544	0.593					
La Liga (Spain)	2018–19	20	0.60	0.08	5.508	0.000	0.022	0.883	−0.01	−0.630	0.532
	2019–20	20	0.61	0.09	5.819	0.000					
Premier League	2018–19	20	0.58	0.08	4.926	0.000	0.230	0.634	−0.01	−0.272	0.787
(England)	2019–20	20	0.59	0.07	5.404	0.000					
Primeira Liga	2018–19	18	0.58	0.08	4.195	0.001	0.274	0.604	0.03	0.970	0.339
(Portugal)	2019–20	18	0.55	0.09	2.628	0.018					
Serie A (Italy)	2018–19	20	0.59	0.10	4.159	0.001	3.147	0.084	0.06	2.369	0.023
	2019–20	20	0.53	0.05	2.596	0.018					
All five leagues	2018–19	96	0.59	0.09	10.149	0.000	0.057	0.811	0.03	2.306	0.023
(Combined)	2019–20	96	0.56	0.09	6.849	0.000					

Table 4. Comparison of HA in 2018/19 versus 2019/20 (paired samples of teams present in both seasons).

		HA		Paired samples test	
League (country)	*N*	Mean difference	Standard deviation	*t*	Sig.
Bundesliga (Germany)	15	0.06	0.10	2.137	0.051
La Liga (Spain)	17	−0.005	0.11	−0.170	0.867
Premier League (England)	17	−0.004	0.09	−0.208	0.838
Primeira Liga (Portugal)	15	0.02	0.13	0.713	0.488
Serie A (Italy)	17	0.07	0.08	3.889	0.001
All five leagues (Combined)	81	0.03	0.10	2.396	0.019

6. Discussion

Table 5. Comparison of HA between fixtures contested with crowds and behind-closed doors in 2019/20 (all matches).

			HA		Levene's test for equality of variances		*t*-test for equality of means		
League (country)	Crowds	*N*	Mean	Standard deviation	*F*	Sig.	Mean difference	*t*	Sig.
Bundesliga (Germany)	Yes	223	0.54	0.44	0.022	0.882	0.10	1.778	0.076
	No	83	0.44	0.44					
La Liga (Spain)	Yes	269	0.62	0.41	0.111	0.739	0.08	1.679	0.094
	No	111	0.54	0.43					
Premier League (England)	Yes	288	0.57	0.43	0.369	0.544	−0.003	−0.062	0.951
	No	92	0.58	0.44					
Primeira Liga (Portugal)	Yes	216	0.53	0.43	0.027	0.869	−0.04	−0.825	0.410
	No	90	0.57	0.43					
Serie A (Italy)	Yes	250	0.51	0.44	0.188	0.665	0.04	−0.837	0.403
	No	130	0.55	0.44					
All five leagues (Combined)	Yes	1246	0.56	0.43	0.154	0.695	0.02	0.785	0.433
	No	506	0.54	0.44					

Table 6. Comparison of HA between fixtures contested with crowds and behind-closed doors in 2019/20 (paired samples of matches contested with and without crowds).

		HA		Paired samples test	
League (country)	*N*	Mean difference	Standard deviation	*t*	Sig.
Bundesliga (Germany)	83	0.14	0.62	2.048	0.044
La Liga (Spain)	111	0.07	0.64	1.195	0.235
Premier League (England)	92	−0.02	0.72	−0.218	0.828
Primeira Liga (Portugal)	90	0.01	0.67	0.079	0.937
Serie A (Italy)	130	−0.03	0.67	−0.591	0.556
All five leagues (Combined)	506	0.03	0.66	0.940	0.348

matches incorporating all five leagues, the HA scores for matches played with crowds ($n = 1246$) and matches played behind closed doors ($n = 506$) did not differ significantly ($p > 0.10$). None of the individual leagues examined returned statistically significant variations in HA between matches with crowds and without crowds ($p > 0.05$).

When we restricted the analysis to the sub-sample of fixtures contested with and without crowds by the same set of teams during the season, a paired samples t-test revealed a statistically significant reduction in HA in the German Bundesliga when crowds were removed ($p < 0.0.5$), but there were no other significant results – see Table 6.

This paper contributes to the debate on the causes of HA in sport. The overarching aim of this study was to examine whether the presence/absence of crowds influences HA in domestic football leagues. As a direct consequence of COVID-19, football leagues across Europe were faced with the prospect of completing their seasons behind closed doors or the alternative of curtailing their seasons altogether. Five European football leagues that had a considerable portion of their fixtures contested behind closed doors during the 2019/20 season due to COVID-19 restrictions were selected for analysis. Our study can be described as a natural experiment that relied on a unique source of exogenous variation in the number spectators in these leagues in order to test whether what some authors like Dohmen (2008) and Dawson and Dobson (2010) have previously referred to as "social pressure" (exerted via the crowd) affects match outcomes.

When the data from all five leagues were pooled, we found evidence of a significant and positive HA effect during both the 2018/19 and 2019/20 seasons. The prevalence of HA in our study is entirely consistent with previous research (Pollard & Gómez, 2014a; Pollard et al., 2017; Leite & Pollard, 2018). The finding that HA exists even in a season during which a critical mass of matches were played without crowds being present in the stadia lends support to a previous study by Van de Ven (2011), which was based on a small sample of 20 matches in Italian football leagues during the 2006/07 season that were held in empty stadiums for safety reasons, as well as more recent work by Sors et al. (2020) who analyzed a sample of football matches held behind closed doors across the top two divisions of four countries during the 2019/20 season. Our study encompasses more countries than Sors et al. (2020) as well as more top division fixtures without spectators (506 versus 415). Sors et al. (2020) calculated HA for their full sample (both first and second divisions) of matches without spectators at 54.68%, which is virtually identical to the HA score for our aggregate sample of 506 top division fixtures behind closed doors (0.54 or 54%).

HA between 2018/19 and 2019/20 declined significantly by around three percentage points for our aggregate sample. This finding also resonates with Sors et al. (2020), who reported a five-percentage point decrease in HA for all first and second division matches played behind closed doors in 2019/20 relative to matches from the three previous seasons played with spectators. While Sors et al. (2020) did not examine HA from the perspective of individual leagues, our study does reveal some league-specific nuances. The Italian Serie A was the only league examined for which a significant decline in inter-season HA was observed consistently. This finding might be related to the fact that Serie A had the highest number and proportion of fixtures contested behind closed doors during 2019/20 within our sample of leagues. There was also some evidence to support a similar inter-season decline in HA for the German Bundesliga. By contrast, for the English Premier League, Spanish La Liga and Portuguese Primeira Liga there was no evidence to suggest that HA had either decreased or increased significantly in 2019/20 relative to 2018/19.

When we considered the fixtures within the 2019/20 season in isolation, the German Bundesliga was the only league in our sample for which there was any evidence of a significant reduction in HA when crowds were removed. This finding is consistent with a recent study by Tilp and Thaller (2020), who observed proportionally fewer home wins in matches that were played without an audience in the

Bundesliga in 2019/20. Relative to the other four top division football leagues examined in our study, the Bundesliga had the highest average attendance recorded across 83 matches played with crowds in 2019/20 (contested between teams that also played each other behind closed doors later during the same season) as well as the second highest crowd density (ratio of average attendance to stadium capacity) in those matches (41,322 and 92%, respectively). Intra-season HA was of a comparable magnitude and did not change significantly for the top division football leagues in England, Spain, Italy, and Portugal in matches played behind closed doors in 2019/20. These leagues had relatively low average attendances compared with the Bundesliga and, with the exception of the English Premier League, also had relatively lower capacity utilization rates.

The process by which crowds are thought to affect HA is either via the players or referee or both (Boyko et al., 2007; Nevill et al., 2002; Ponzo & Scoppa, 2018). Therefore, a possible explanation for our largely insignificant findings for most of the individual leagues examined could be that, when playing away from home, players in certain leagues (e.g. the English Premier League) might be better trained to cope with the hostile environment created by supporters of the home team. It is also possible that referees in these leagues are less likely to be influenced by the noise of the home crowd when making key decisions during matches.

Some studies have confirmed the absence of referee bias in favor of home teams in football matches played behind closed doors in certain domestic leagues. Using data from the top two divisions of Italian football from the 2006/07 season, when some teams had to temporarily play their home matches in empty stadiums due to tightened safety regulations, Pettersson-Lidbom and Priks (2010) concluded that referees changed their behavior significantly in matches played without spectators and exhibited home bias when spectators were present. More recently, Sors et al. (2020), reported no difference between home teams and away teams for any of their referee bias variables (fouls, yellow cards, red cards, penalty kicks, and extra time) in the absence of spectators across four European countries. By contrast, Tilp and Thaller (2020) found that a balanced distribution of fouls committed between home and away teams in Bundesliga matches without an audience during the 2019/20 season; this differed significantly from the previous matches during the season with spectators, when home teams committed on average fewer fouls than the away teams.

If empty stadiums contributed to more balanced decisions by referees in the Bundesliga in 2019/20 (Tilp & Thaller, 2020), then this factor could have influenced the observed reduction in intra-season HA for Bundesliga matches played behind closed doors in our study. On the basis that HA and referee bias in favor of home teams are seen as being logically interrelated phenomena (Sors et al., 2020), the findings of our study appear to vindicate the continued use of remotely operated video assistant referee (VAR) technology in the Bundesliga to support the decision making process of the on-field referees, in order to mitigate any unconscious bias caused by social pressure from home spectators. The use of VAR is also pertinent to other leagues from the point of view of ensuring that correct decisions are made, regardless of whether such decisions are in favor of home or away teams.

Despite the potential explanation of reduced referee bias in matches without crowds in the Bundesliga being responsible for a decline in HA in 2019/20, on

balance there is insufficient evidence from our study to conclude that crowds contribute to the occurrence of HA in football on a consistent basis, at least in terms of the final match outcome. Due to the archival nature of the data underpinning this study, even for those leagues where a crowd effect may appear to exist, it is not possible to pinpoint how this effect might be manifested. Ultimately, we cannot discern the extent to which: (i) the apparent lessening of inter-season HA in Serie A between 2018/19 and 2019/20 and reduction in intra-season HA in the Bundesliga for matches played behind closed doors during 2019/20 can be attributed to the absence of crowds; (ii) the presence/absence of the crowd has a direct effect on HA by influencing the performances of home and away teams; (iii) the presence/absence of the crowd influences referee bias and thereby has an indirect effect on HA; and, (iv) other factors such as familiarity and territoriality contribute to the occurrence of HA.

The inconclusive findings from our study coupled with the mixed evidence of the effect of crowd size and density on HA in football from previous research (Goumas, 2013, 2014a, 2014b; Pollard & Armatas, 2017) means that, conceptually, the relevance of home crowd support as a key "game location factor" that affects team performance at a "tertiary" level (i.e. win, draw or loss) as proposed in traditional conceptual models of HA (Courneya & Carron, 1992; Carron et al., 2005) remains unproven. Equally, there is no evidence from our study to suggest that crowds may have an adverse impact on the performance of home teams as suggested by some commentators (Baumeister & Steinhilber, 1984; Wallace et al., 2005).

Looking beyond the role of the crowd, another potential contributor to HA relates to the physiological and psychological effects that travel is known to have on football players (Renata & Dezso, 2006; Waters & Lovell, 2002). All of the leagues in our sample represented the top national divisions of their respective countries. When travelling to play matches away from home, teams that play in the top national divisions are more likely to do so in relative comfort, which would serve to mitigate the potential disadvantage of travelling between cities. Research has also shown that HA reduces in "local derbies" contested by teams belonging to the same city (Seckin & Pollard, 2008) and there is also evidence that HA disappears in "same-stadium derbies" played between two teams that share the same stadium (Van de Ven, 2011), which suggests that crowd support is not a necessary condition for HA to occur and points to facility familiarity being a likely candidate for HA. While we have not tested or explicitly controlled for these factors, they might potentially influence some of our findings.

7. Conclusions

In conclusion, our study does not provide strong evidence to support the existence of the purported "twelfth man" effect in football. We call for researchers to extend our study by incorporating more leagues from a wider sample of countries to enable more robust conclusions to be drawn. Given that previous research has shown that HA tends to be higher in the second divisions of football leagues (Leite & Pollard, 2018), it is also worthwhile to replicate our analysis for divisions below the topmost tier.

Disclosure statement

No potential conflict of interest has to be reported.

Notes on contributors

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